

long, forming a long and loose mane, the hairs being quite five inches long, and this mane terminated suddenly at the junction of the neck and body.

The hairs down the throat between the head and fore limbs were also very long, quite four inches. On body and limbs my Javan male had no longer hair than the Society's male, and both my animals had the white on cheek-tufts and beard as I have described in the Society's male.

I may remark that both my animals were as thickly striped on the body as the Society's male, which is a point of interest, as Elliot in his 'Monograph of the Felidæ' says that this race is striped as in the Indian race.

Mr. Pocock has pointed out, when remarking on Nepal specimens, that the presence or absence of a few stripes is of no subspecific value, with which statement I think all accurate observers will agree; and judging from a female I saw from North Persia, I think that if a large number of skins were examined, the Persian race as a whole would not be found to be more thickly striped than *Felis tigris sondaica*.

These observations were from stuffed skins and living animals seen by myself, and not from descriptions by other people or from figures of either race. The living specimens were compared with one another within seven days.

3. The Nesting Habits of the Tree-Frog *Phyllomedusa sauvagii*. By W. E. AGAR, M.A., D.Sc., Glasgow University*.

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(Plate LXXXIV.†)

I give here a few notes on the remarkable nesting-habits of a Tree-Frog, *Phyllomedusa sauvagii*, which I found breeding in great abundance in the Paraguayan Chaco from October 1907 till February 1908‡. This frog, like other members of its genus (e. g. *P. jheringii*, *P. hypochondrialis*), makes a nest suspended from bushes, etc. overhanging a pool into which the tadpoles drop when they are hatched. The nest of *P. sauvagii*, however, differs in a noteworthy way from those of the other species of the genus which have been described.

From the examination of the structure of fully formed nests (Pl. LXXXIV. fig. 1), one of which was found half finished, the female still being engaged in adding eggs, the method of oviposition can easily be deduced. First, the lower ends of a number of leaves are drawn together and held so by a deposit of

* Communicated by G. A. Boulenger, F.R.S., V.P.Z.S.

† For explanation of the Plate see p. 896.

‡ The observations were made in the course of a zoological expedition to the Chaco, the expenses of which were defrayed by the Government Grant Committee of the Royal Society and by the Managers of the Balfour Fund at Cambridge University.

empty gelatinous egg-capsules, forming together a stiff jelly. These egg-capsules are of course secretions of the oviduct. They are little solid spheres of jelly, made polygonal by mutual pressure, and except that they are a little smaller are exactly like the capsules laid later and containing eggs.

As the act of oviposition continues, egg-containing capsules begin to appear among the eggless ones, and the bulk of the nest is filled with a mixture of full and empty capsules in about equal numbers. Finally, as oviposition approaches its end, the egg-containing capsules become fewer and fewer, and the last addition to the nest is a mass of empty capsules as at the beginning of the process.*

In order to confirm this view as to the way in which the mass of spawn is made up, which was deduced from examination of a number of nests, I made a dissection of a frog which I had preserved in the act of oviposition, when the nest was about half filled. The dissection (Pl. LXXXIV. fig. 2) shows precisely the conditions to be expected from the structure of the nests. Each ovisac contains a mass of encapsuled eggs and empty (*i. e.* eggless but solid) capsules. The former occupy the postero-ventral and the latter the antero-dorsal portion of the ovisac, but the line of demarcation between the two is not precise. A glance at the figure will show that at the moment when the frog was preserved (in the middle of oviposition) it was laying a mixture of full and empty capsules, but as oviposition continued the proportion of full to empty ones would become less and less, and finally it would be laying empty ones only. The contents of the ovisac of the other side are arranged in a precisely similar way.

The mass of spawn when finished is thus largely, or often even mainly, made up of empty capsules. The egg-containing capsules are embedded in the mass in such a way that in well made nests, such as the one figured, not a single egg is exposed to the light and air, the jelly plug of empty capsules at the top and bottom, and the leaves at the sides forming a complete shield for them.

Each egg is of course enclosed in a vitelline membrane as well as the gelatinous oviducal envelope. As the time for hatching approaches a large quantity of fluid accumulates inside the vitelline membranes, causing them to swell up to twice their proper size and giving the embryos room to make violent movements within the membranes and to give free play to their large external gills, which may be seen moving to and fro.

The fluid inside the vitelline membranes has evidently been extracted from the jelly of the oviducal envelopes, both of those surrounding eggs and of the empty, solid ones; for whereas in the newly laid egg-mass each vitelline membrane fits close round its egg, and is separated from its neighbours both by its own and their own thick oviducal capsules, and also by the empty capsules

* In the figure some of the leaves have been turned aside to expose the egg-mass. In its natural condition none of the eggs were visible, only the mass of empty capsules at the top and bottom being exposed.

distributed among the egg-mass, at the time of hatching the relatively enormously distended vitelline membranes fill a far greater bulk of the nest, and the jelly capsules between them are reduced to an insignificant remnant.

When about to hatch the tensely filled membranes burst at the slightest touch, liberating both embryo and fluid. If a nest is opened soon after the eggs have hatched, it presents a seething mass of tadpoles wriggling about in a thick mucilaginous fluid, formed by the clear liquid from the burst vitelline membranes and the now dissolved remains of the jelly, in the interior of a chamber the sides of which are formed by leaves, and the floor and roof by the plugs of empty capsules.

In order that the larvæ should reach the water beneath them it is necessary that the wall of this chamber should give way somewhere. The fluid above has a softening effect on the gelatinous floor of the nest, and this gradually softens. At a period of about 12-24 hours after the bulk of the larvæ are hatched (there seems to be about a day's interval between the hatching of the first and last larva) a thick mucilaginous drop may be seen to form at the bottom of the nest, and presently there is a steady drip of the deliquesced jelly plug into the water below. After a few minutes a larva slips through and falls into the pond beneath. A few seconds later two or three more come through in the same way and then they come faster and faster as the whole semi-fluid contents of the nest continues falling drop by drop into the water, taking the larvæ with it. One nest, in which I watched the whole process, took five minutes to empty itself, in which time over 300 tadpoles fell from it into the water.

It sometimes happens that a nest is hung a few inches from the edge of the water. In this case the tadpoles suffer no inconvenience from falling on the dry earth, but being extremely agile quickly flick themselves into the water. Budgett mentions this happening in *P. hypochondrialis* also.

The larvæ, like the aquatic young of so many other vertebrates, exhibit a retraction of their chromatophores at night and an expansion in the daytime.

The most interesting feature of this process is the part played by the empty egg-capsules, which may be said to be three-fold.

First,—The plugs at the top and bottom of the nest provide shields from the sun and air for the eggs, where the leaves do not protect them. The eggs are quite unpigmented, and any that are exposed to the surface, as happens often in less perfectly formed nests, turn yellow and die.

Secondly,—The empty capsules mixed with the full ones in the body of the nest provide an extra source of fluid for the developing embryo, and for the newly hatched larva, as already described.

Thirdly,—The plug at the bottom serves to keep the whole nest intact, until the rather diffuse process of hatching is completed, and all the larvæ are ready to fall into the water.

The large number of empty capsules mixed with the full ones

is very striking, and still more so is the definite arrangement of the proportions in which they are produced in different periods of oviposition. We must suppose that at the beginning of the process the oviducts secrete a large number of capsules before the eggs begin to pass down them, and again at the end must continue to do so after the last egg has passed. The actual production of empty capsules is only what may be found, though to a very much smaller extent, in probably any Anuran. If a batch of *Rana temporaria* spawn be looked over, a few empty capsules—perhaps 2 or 3 per cent.—will generally be found. *P. sauvagii*, however, has developed this peculiarity to an enormous extent and also controlled it in the way we have seen.

The nests are not always so perfect as the one figured. Often gaps are left between the edges of the leaves, exposing some or many of the eggs to the light. Such exposed eggs if they are near the surface die. Sometimes also the jelly plugs at top and bottom contain a few eggs. Such eggs, being exposed, also die. It is significant that the actual percentage of eggs hatched is thus greater in perfect nests than in the less perfect ones often found, for we see that the advantage in productivity of the frogs which make the best nests—*i. e.*, frogs in which the oviducts secrete a sufficient number of empty capsules, especially at the beginning and end of oviposition, and which also make the best use of the leaves to cover the sides of the nest—must tend to perfect the process.

The question of how rounded egg-capsules are formed without eggs as nuclei to form round, is one to which I have not found any clue by the dissection of the oviducts, which were nearly empty in both females I opened. I can only say that I found empty capsules far up in the glandular portion of the oviduct, as well marked off from one another as in the ovisacs.

REFERENCES.

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EXPLANATION OF PLATE LXXXIV.

Both the figures were drawn from preserved specimens by Mr. A. K. Maxwell. They are of natural size.

- Fig. 1. A nest of *Phyllomedusa sauvagii*. It is hanging in its natural position. Some of the leaves have been turned aside to expose the egg-containing portion of the mass of spawn. *e.c.l.*, mass of empty egg-capsules, forming the bottom of the nest. *e.c.u.*, empty capsules forming the roof of the nest. *oc.*, egg-containing portion of the mass of spawn.
Fig. 2. Dissection of a female *P. sauvagii* preserved when it had about half filled its nest. *od.*, oviduct. *ovs.*, ovisac, containing full and empty capsules arranged as described in the text.

[While the above was in the press, I have seen M. Siedlecki's

